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INSTRUMENTS THAT STAY ACCURATE

STABRO LABORATORIES INC.
TECHNICAL REFERENCE LIBRARY
DOCUMENT CONTROL ADMINISTRATOR

OPERATOR'S MANUAL

WARNING

For safe usage, it is essential that the operator read this manual carefully before using the instrument for any measurements.

MODEL 2795
ELECTRONIC MULTIMETER

SIMPSON ELECTRIC COMPANY
853 Dundee Ave., Elgin, Illinois 60120
Area Code 312, Telephone 695-1121
In Canada, Bach-Simpson, Ltd., London, Ontario

Warranty

SIMPSON ELECTRIC COMPANY warrants each instrument and other articles of equipment manufactured by it to be free from defects in material and workmanship under normal use and service, its obligation under this warranty being limited to making good at its factory any instrument or other article of equipment which shall within 90 days after delivery of such instrument or other article of equipment to the original purchaser be returned intact to it, or to one of its authorized service stations, with transportation charges prepaid, and which its examination shall disclose to its satisfaction to have been thus defective; this warranty being expressly in lieu of all other warranties expressed or implied and of all other obligations or liabilities on its part, and SIMPSON ELECTRIC COMPANY neither assumes nor authorizes any other persons to assume for it any other liability in connection with the sale of its products.

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Simpson
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ELECTRIC COMPANY
853 Dundee Ave., Elgin, Illinois 60120 Phone: (312) 695-1121
IN CANADA: Bach-Simpson, Ltd., London, Ontario
IN ENGLAND: Bach-Simpson (U.K.) Limited, Wadebridge, Cornwall
IN INDIA: Ruttonsha-Simpson Private, Ltd., International House, Bombay-Agra Road, Vikhroli, Bombay

KATY INDUSTRIES
ELECTRICAL EQUIPMENT GROUP

OPERATOR'S MANUAL

MODEL 2795 SOLID-STATE ELECTRONIC MULTIMETER

SIMPSON ELECTRIC COMPANY

853 Dundee Ave., Elgin, Illinois 60120
Area Code 312, Telephone 695-1121
In Canada, Bach-Simpson, Ltd., London, Ontario

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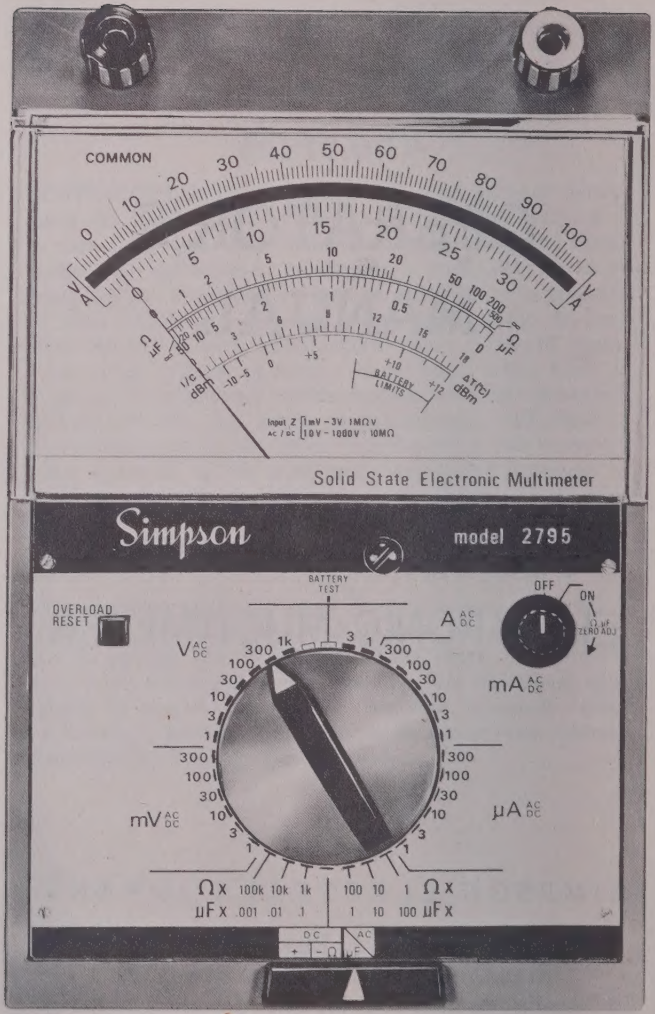


FIGURE 1. THE SIMPSON MODEL 2795 SOLID-STATE ELECTRONIC MULTIMETER

USE OF THIS MANUAL

You are now the owner of one of the finest measuring instruments available – the Simpson Model 2795 Solid-State Electronic Multimeter. Its wide measurement range and high accuracy make it a valuable aid in test facilities, laboratories, radio and television service, and any applications where measurements have to be made without using line power. The 2795 combines the advantages of classic measuring techniques with those of modern electronics.

This manual, carefully followed, will help you to get the best use out of your 2795. We urge you to refer to it before undertaking any operation with the instrument and to keep it handy after you familiarize yourself with the multimeter.

Tables relating to the measurement of a particular parameter (e.g., voltage) will be found in the section discussing that parameter's measurement. Data on extended-range operation using accessories can also be found in that section.

Tabular data relating to all parameters (with direct-connection operation) are printed for your convenience on the back of the instrument.

SAFETY

ALWAYS TURN OFF ALL POWER TO A CIRCUIT BEFORE MAKING ANY CONNECTIONS FOR MEASUREMENTS IN THAT CIRCUIT. NEVER TOUCH TEST LEADS OR PROBES WHILE A MEASUREMENT IS BEING MADE.

TABLE OF CONTENTS

	SUBJECT	PAGE NO
1.	**GENERAL INFORMATION**	1
1.1.	BASIC FUNCTION	1
1.2.	MAJOR ADVANTAGES	1
2.	**ACCURACY**	3
2.1.	TEST CONDITIONS FOR DETERMINATION OF ACCURACY	3
2.2.	FOR VOLTAGE AND CURRENT	3
2.3.	FOR RESISTANCE AND CURRENT	3
2.4.	FREQUENCY EFFECT	3
2.5.	FOR SUPERIMPOSED DC-AC VOLTAGE AND CURRENT	3
2.6.	TEMPERATURE INFLUENCE	4
2.7.	WAVE-SHAPE INFLUENCE	4
2.8.	INSULATION VOLTAGE	4

TABLE OF CONTENTS (Continued)

	SUBJECT	PAGE NO
3.	CHECKING THE INSTRUMENT	4
3.1.	EXAMINATION FOR DAMAGE	4
3.2.	CHECKING THE BOX CONTENTS	4
4.	DESCRIPTION AND OPERATION	4
4.1.	SAFETY	4
4.2.	SPECIFICATIONS PANEL	6
4.3.	OPERATING LOCATION AND POSITION	6
4.4.	BATTERIES	6
4.5.	MULTIMETER JACKS	7
4.6.	MULTIMETER DIAL	7
4.7.	RANGE ADJUSTMENT PANEL	8
4.8.	MECHANICAL ZERO ADJUSTER	8
4.9.	BATTERY SWITCH AND RHEOSTAT	8
4.10.	RANGE SELECTOR	10
4.11.	FUNCTION SWITCH	10
5.	OVERLOAD PROTECTION	10
5.1.	OVERLOAD DEFINITION	10
5.2.	OVERLOAD INDICATION	12
5.3.	LOW POWER OVERLOAD	12
5.4.	OVERLOAD RESET POPPING OUT	12
5.5.	SAFETY FUSE	13
5.6.	SPARK GAP	13
6.	MEASUREMENT OF VOLTAGE AND CURRENT	14
6.1.	D.C. CIRCUIT OPERATION FOR VOLTAGE AND CURRENT MEASUREMENTS	14
6.2.	A.C. CIRCUIT OPERATION FOR VOLTAGE AND CURRENT MEASUREMENTS	18
6.3.	MEASUREMENT OF DC VOLTAGE UP TO 30,000 V	19
6.4.	MEASUREMENT OF DC AND AC CURRENT UP TO 3 A	21
6.5.	MEASUREMENT OF DC CURRENT UP TO 100 A	23
6.6.	MEASUREMENT OF AC CURRENT UP TO 600 A	25
6.7.	MEASUREMENT OF SUPERIMPOSED DC-AC VOLTAGE AND CURRENT	26

7. MEASUREMENT OF RESISTANCE AND CAPACITANCE 28
7.1. CIRCUIT OPERATION FOR RESISTANCE AND CAPACITANCE MEASUREMENTS. 28
7.2. MEASUREMENT OF RESISTANCE 30
7.3. RESISTANCE-SCALE MEASUREMENT OF DIODES AND TRANSISTORS 32
7.4. MEASUREMENT OF CAPACITANCE. 34

8. MEASUREMENT OF TEMPERATURE 37
8.1. EQUIPMENT AVAILABLE 37
8.2. METHOD OF MEASUREMENT AND VALUES 37

9. MEASUREMENT OF POWER EXPRESSED IN DECIBELS 40

10. MAINTENANCE AND PARTS LIST 41

FIGURES

	TITLE	PAGE NO
FIGURE 1.	THE SIMPSON MODEL 2795 SOLID–STATE ELECTRONIC MULTIMETER . . .	ii
FIGURE 2.	BASIC EXTERNAL COMPONENTS OF THE 2795 MULTIMETER	5
FIGURE 3.	THE MULTIMETER DIAL.	9
FIGURE 4.	OVERLOAD PROTECTION CIRCUITRY. SIMPLIFIED DIAGRAM	11
FIGURE 5.	CIRCUITRY FOR VOLTAGE AND CURRENT MEASUREMENTS, SIMPLIFIED DIAGRAM	15
FIGURE 6.	DIRECT CONNECTIONS FOR DC AND AC VOLTAGE MEASUREMENTS UP TO 1000 V	17
FIGURE 7.	CONNECTIONS USING THE 22926 HIGH–VOLTAGE PROBE	20
FIGURE 8.	DIRECT CONNECTIONS FOR DC AND AC CURRENT MEASUREMENTS	22

FIGURE 9. 06531 EXTERNAL DC SHUNT AND 02462 CLAMP-ON AC CURRENT TRANSFORMER. BASIC DESIGN 24

FIGURE 10. CIRCUITRY FOR RESISTANCE AND CAPACITANCE MEASUREMENTS. SIMPLIFIED DIAGRAM 29

FIGURE 11. TEMPERATURE PROBES FOR THE 2795. BASIC DESIGN 38

BASIC CIRCUIT DIAGRAM 1 43

BASIC CIRCUIT DIAGRAM 2 44

PL (PARTS LIST) DRAWING 1 48

PL DRAWING 2 49

PL DRAWING 3 50

TABLES

TABLE 1. VOLTAGE DROPS AT DIFFERENT CURRENT SETTINGS 16

TABLE 2. OPERATING DATA FOR THE 06531 EXTERNAL SHUNT 23

TABLE 3. OPERATING DATA FOR THE 02462 CLAMP-ON CURRENT TRANSFORMER 25

TABLE 4. RESISTANCE RANGE DATA 30

TABLE 5. CONNECTIONS FOR FORWARD AND REVERSE CURRENT (DIODE AND TRANSISTOR CHECKING) 33

TABLE 6. CAPACITANCE RANGE DATA 35

TABLE 7. ADDED dBm VALUES 41

1. GENERAL INFORMATION

1.1. BASIC FUNCTION

The Simpson Model 2795 is a solid-state electronic multimeter. It is battery-powered and portable. The instrument incorporates a taut-band, permanent-magnet, moving-coil movement, and measures voltage, current, resistance, capacitance, temperature, and *dBm* power. You will find the 2795 to be especially valuable in:

1) The measurement of values in solid-state circuitry.
2) Applications where very low power is desirable, such as resistance measurements in *IC* circuits.
3) Locations without access to line power.

1.2. MAJOR ADVANTAGES

As you use the 2795, you will find the special features incorporated in the design make measurements and operation much easier than is the case with conventional instruments. These features include:

Extensive and diversified measurement range

Includes 54 *DC* and *AC* ranges in steps of 1: $\sqrt{10}$; 12 resistance and capacitance ranges; 2 temperature ranges; and 13 ranges for *dBm* power. Accessories available for extended-range operation.

Overload protection relay

Automatically breaks the measuring circuit when a voltage or current overload occurs, thus preventing damage to the instrument.

High sensitivity

Sensitivity of 1 *mV* and 1 μA, *DC* and *AC*, provided by a transistorized battery-powered, fixed-gain *DC* and *AC* amplifier.

Excellent stability and negligible drift

Made possible through:

1) Multiple negative feedback.
2) An *MOS FET* chopper (used in *DC* measurements).

High accuracy

$\pm$1% of full-scale reading for *DC* and *AC* current and voltage measurements in both regular-output and superimposed-component systems. (For more on superimposed-component system accuracy, see 2.5).

Maximum reliability

Taut-band suspension movement, overload protection relay (see above), fuse for higher current ranges, and printed circuits.

Easy-to- read scale

Uncluttered, well marked scales protected by shadow-free, impact resistant glass. Same linear scale for *DC* and *AC*.

Low power consumption

Battery life is approximately 1200 hours.

Easy operation

Design and arrangement of both internal and external components make quick, accurate operation possible.

2. ACCURACY

2.1. TEST CONDITIONS FOR DETERMINATION OF ACCURACY

Accuracy of the 2795 has been developed by design engineers striving over a long period of time to meet the maximum standards required in multimeter measurement of different parameters. The results of their work are reflected in the accuracy values in 2.2, 2.3, 2.4, 2.5, 2.6, and 2.7. These values hold true under the following conditions:

1) Multimeter used in the horizontal position.
2) Ambient temperature of 25°*C*.
3) *AC* input to be a sine-wave at a frequency of 50 to 60 *Hz*.

2.2. FOR VOLTAGE AND CURRENT

±1% of full scale.

2.3. FOR RESISTANCE AND CAPACITANCE

±1% of scale length.
(±4% of reading at mid-scale)

2.4. FREQUENCY EFFECT

(For voltages up to 100 *V* and currents up to 0.3 *A*.)
Less than 1.5% of full-scale change from 25 to 5000 *Hz*.

Less than 4% of full-scale change from 15 to 20,000 *Hz*.

2.5. FOR SUPERIMPOSED DC–AC VOLTAGE AND CURRENT

In superimposed *DC* and *AC* voltage and current measurements, rejection or sufficient reduction of the superimposed component makes it possible to achieve an accuracy of ±1% in measuring the output component. See 6.7. which discusses the measurement of superimposed *DC-AC* voltage and current.

2.6. TEMPERATURE INFLUENCE

$< \pm 1\%/10^{\circ}C$ change within a temperature range of 0° to $50^{\circ}C$.

2.7. WAVE SHAPE INFLUENCE

The 2795 is calibrated to read root-mean-square values of sine-wave and non-sinusoidal AC waves. This calibration includes allowance for the form factor, which for a pure sine wave is 1.11 (the root-mean-square value divided by the average value). A peaked wave causes a negative error anda square wave a positive error.

2.8. INSULATION VOLTAGE

The insulation voltage of the 2795 is 3000 V.

3. CHECKING THE INSTRUMENT

3.1. EXAMINATION FOR DAMAGE

After opening the styrofoam box, examine the instrument carefully for damage from shock, water leakage, or other causes. If any damage is found, notify the shipper or dealer immediately.

3.2. CHECKING THE BOX CONTENTS

Check the box in which the instrument was shipped for one pair of red and gray leads with insulated clips.

4. DESCRIPTION AND OPERATION

(Refer to Figure 2 on page 5 as you read these instructions. A number in parenthesis after the name of each component is its number in Figure 2.)

4.1. SAFETY

Form the habit of turning off the power to a circuit before making connections for voltage or current measurements of that circuit.

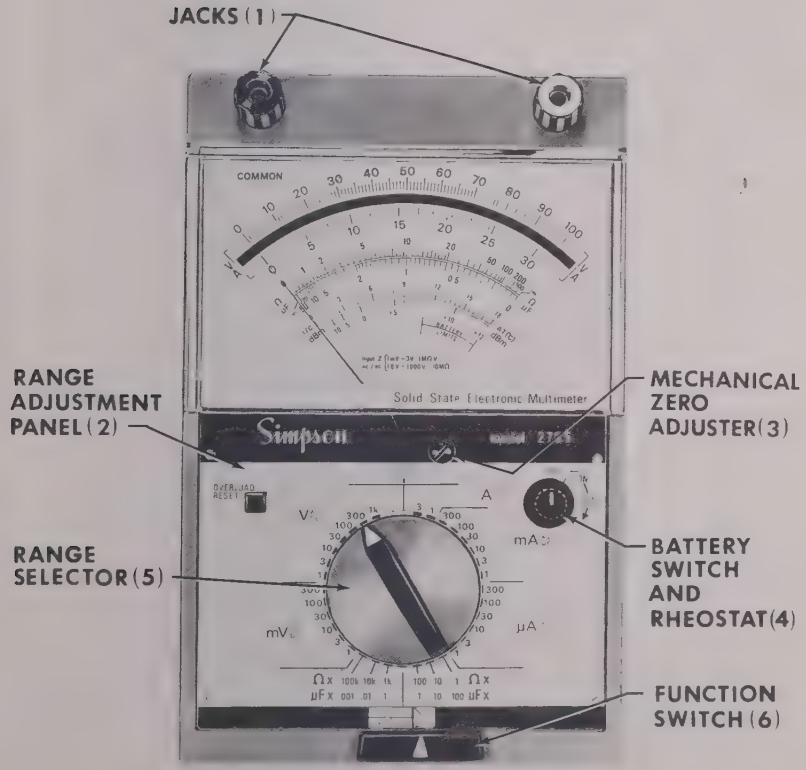


FIGURE 2. BASIC EXTERNAL COMPONENTS OF THE 2795 MULTIMETER

4.2. SPECIFICATIONS PANEL

On the back of the 2795 is the specifications panel. For quick reference, refer to these data: *They apply to direct-connection operation only.* For extended-range operation, refer to the section or sections on the desired measurement.

4.3. OPERATING LOCATION AND POSITION

Measurement errors can occur if the instrument is used near large magnetic masses, other magnetic fields such as high-current-carrying leads and bus bars, or other permanent-magnet, moving coil instruments. Measurement errors can also occur if the instrument is used in a vertical instead of a horizontal position.

4.4. BATTERIES

Four 1½-volt C cells are normally used with the 2795; if these are not available, two 3-volt batteries can be used with two adapters to meet the power requirements. The batteries should be inserted into the battery compartment, visible when the base plate (the back of the instrument) is removed.

Loosen the base plate retaining screw on the back of the instrument, near the bottom, with a coin or suitable screwdriver, and remove the base plate. Then insert the cells into the compartment, making sure that they are correctly positioned for polarity. Replace the base plate.

Battery consumption is very low (approximately 2½ *milliamperes).* Proper operation can be maintained over a battery voltage range of *4 to 7 volts* so you need check the batteries only after long periods of operation. Battery life is approximately 1200 hours.

Battery voltage may be checked in the following way:

1) Disconnect the instrument from any circuit with which it has been connected.

2) Turn the battery switch (4) to *ON*. Allow about one minute for the circuit to stabilize and the pointer to deflect.

3) Rotate the range selector (5) to the position *BATTERY TEST* at the top of the circular selector dial.

4) Move the function switch (6) to *DC.* – Ω.

If the reading is within the scale designated *BATTERY LIMITS* (on the *dBm* scale, see Figure 3, page 9), the instrument has adequate battery power.

4.5. MULTIMETER JACKS (1)

Jacks for the 2795 are located on the front of the unit: the ground jack marked *COMMON* on the left and the jack with the red insert on the right. Connections from the circuit to be measured are inserted in the jacks according to instructions given on the measurement of different parameters, e.g., on the measurement of voltage and current.

4.6. MULTIMETER DIAL

The multimeter dial, located at the top of the instrument, contains the following scales (starting from the top and reading down):

0 to 100 *V–A* scale and 0 to 30 *V–A* scale (Voltage and current measurements)

0 to 100 Ω and k Ω scale (Resistance measurements)

1 to 50 μF scale(Capacitance measurements)
0 to 18°C scale (Temperature measurements)
– 10 to +12 *dBm* scale (Power measurements)
BATTERY LIMITS scale

Refer to Figure 3 on page 9. This figure shows the dial.

4.7. RANGE ADJUSTMENT PANEL (2)

The range adjustment panel is located beneath the multimeter dial and contains the controls listed in 4.7 through 4.11. The overload reset, also located on the range adjustment panel, is covered under **5. OVERLOAD PROTECTION.**

4.8. MECHANICAL ZERO ADJUSTER (3)

The mechanical zero adjuster, located center, top, on the range adjustment panel, permits adjustment of the pointer when there is no current flowing through the instrument, so that it rests exactly at the zero end of each scale. Before switching the unit to *ON*, check to see if the pointer is at this position. If it is not, use a small screwdriver to turn the zero adjuster until the pointer rests exactly on zero. No measurements should be made until the adjuster has been properly set.

4.9. BATTERY SWITCH AND RHEOSTAT

As indicated in 4.4., when the battery switch is turned to the *ON* position, the power is turned on. Allow about one minute for the circuit to stabilize after switching to *ON*. This waiting period can be eliminated, if you wish, by leaving the battery on the entire working day. Current consumption is only 2.5 *mA*.

At the Ω, *μF, Zero ADJ.* position, located clockwise from the *ON* position, resistance and capacitance measurements are made. In contrast to the *ON* position, the Ω, *μF Zero ADJ.* position is an adjustment range, within which a full scale reading for resistance and capacitance can be obtained. The arrow indicates the direction in which the control should be turned in order to get a full-scale reading. The lower the battery voltage, the further the battery switch must be turned.

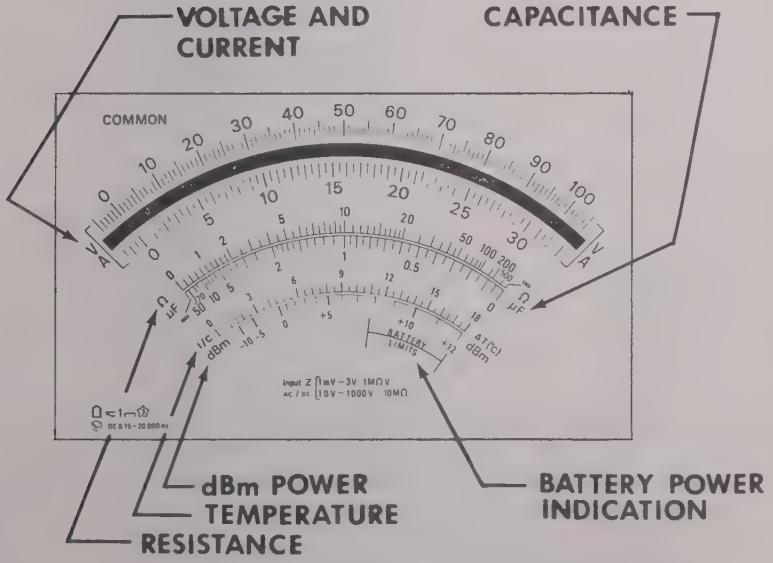


FIGURE 3. THE MULTIMETER DIAL

4.10. RANGE SELECTOR (5)

In the middle of the range adjustment panel is the range selector. The selector has settings for battery test; volts and millivolts; amperes, milliamperes, and microamperes, and range factors to be used in the measurement of resistance and capacitance.

4.11. FUNCTION SWITCH (6)

The function switch is located directly below the range selector. It has three positions:

1. *DC,+*
2. *DC, – Ω*
3. *AC/μF*

When the reading of the instrument is positive, the + or – polarity indication of the function switch is valid for the instrument's red-inserted jack.

5. OVERLOAD PROTECTION

Refer to Figure 2 on page 5 for the position of the overload reset on the range adjustment panel. See Figure 4, page 11, for the overload protection circuitry, when reading Sections 5.1 through 5.6.

5.1. OVERLOAD DEFINITION

Overload is caused by a setting of the range selector on a range that is lower than the actual voltage or current value in the circuit being measured.

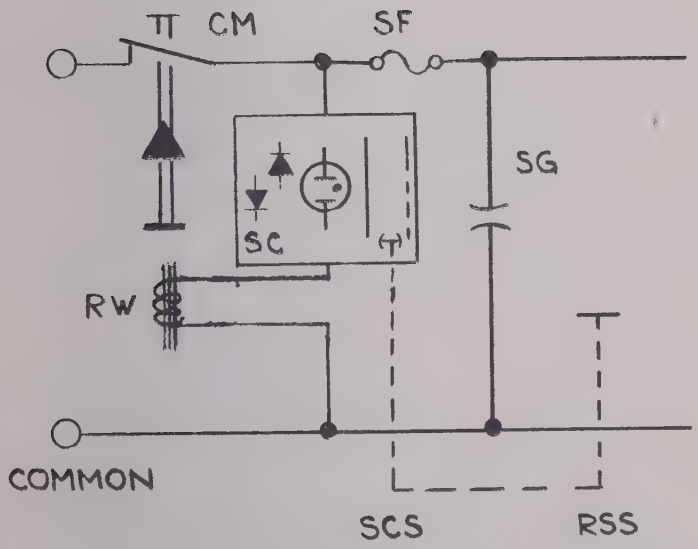


FIGURE 4. OVERLOAD PROTECTION CIRCUITRY, SIMPLIFIED DIAGRAM

5.2. OVERLOAD INDICATION

Overload on the 2795 is indicated in two ways:

1) By the pointer running off scale only.
2) The overload reset popping out and the pointer running off scale.

5.3. LOW POWER OVERLOAD

A low power overload, indicated by the pointer swinging off scale, but the overload relay not tripping, can occur. This will happen when the setting on the range selector is lower than the actual voltage or current value of the circuit being measured, but not low enough to actuate the overload relay (explained in 5.4.). This response to overload depends entirely upon the range selector setting and the circuit being measured.

5.4. OVERLOAD RESET POPPING OUT

The overload reset has two operating positions: in and out. It remains in the *in* position when there is no overload and also under the overload condition indicated under 5.3.

However, when the overload is great enough, the overload relay contact mechanism (CM) will break the measuring circuit and the overload reset will pop out. The pointer may momentarily be driven off scale.

If the overload condition is not corrected, the reset can be pushed in, but it will not hold in the *in* position. This is protection against restoring the overloaded circuit, which could damage the instrument.

By making the correct setting on the range selector, you will be able to push the reset in so that it will hold in the *in* position.

Figure 4 shows the overload relay protective circuit breaker that is actuated to break the circuit and cause the overload reset to pop out. The relay windings (RW) of the circuit breaker are connected to a selector circuit (SC). The selector circuit switch (SCS) connects the circuit to the range selector switch (RSS).

The overload relay is thus responsive to whatever setting has been made on the range selector. If, as indicated above, the range selector is at a setting much lower than the true value of the circuit being measured, the relay will immediately actuate its contact mechanism (CM) to break the measuring circuit.

The overload relay will operate whether:

1) The overload is *DC or AC.*
2) The battery switch is on or off.
3) A battery is discharged.

As mentioned above, the overload reset will not hold in the *in* position until an adjustment is made, using the range selector, to remove the overload. This is not possible in all cases.

5.5. SAFETY FUSE

A safety fuse (SF) with a current rating of *4 A* is connected in series with the instrument's unmarked input terminal to protect the multimeter when high-current ranges are being used. The fuse will blow before the overload relay operates. It also prevents short-circuit damage.

5.6. SPARK GAP

A spark gap (SG) is connected to the input jacks. The

flashover voltage of the gap is lower than the breakdown voltage of the 2795 · internal circuitry. This prevents the multimeter from being damaged when excessive voltages (voltage peaks) are encountered during the testing of equipment such as TV receivers, magnetic amplifiers, high-DC inductance equipment, etc.

There is also a diode-protection arrangement for the electronic circuits. This is not shown in Figure 4.

6. MEASUREMENT OF VOLTAGE AND CURRENT (DC AND AC)

6.1. DC CIRCUIT OPERATION FOR VOLTAGE AND CURRENT MEASUREMENTS

Refer to Figure 5.

A DC signal passes first through the range selector switch (RSS) to a voltage divider (R), then to a filter (F), and next to an MOS-FET chopper (Ch), where it is chopped into pulses before entering a fixed-gain amplifier (FGA). At the amplifier output, it is synchronously rectified by a field-effect transistor (FET). Both the chopper and the field-effect transistor are controlled by a square-wave generator (SWG).

Amplifier gain is adjusted for DC, AC, or capacitance by the sensitivity control switch (SCS), which in turn is connected to the function switch (FS). The meter movement (M) responds directly to any of the 3 function switch settings.

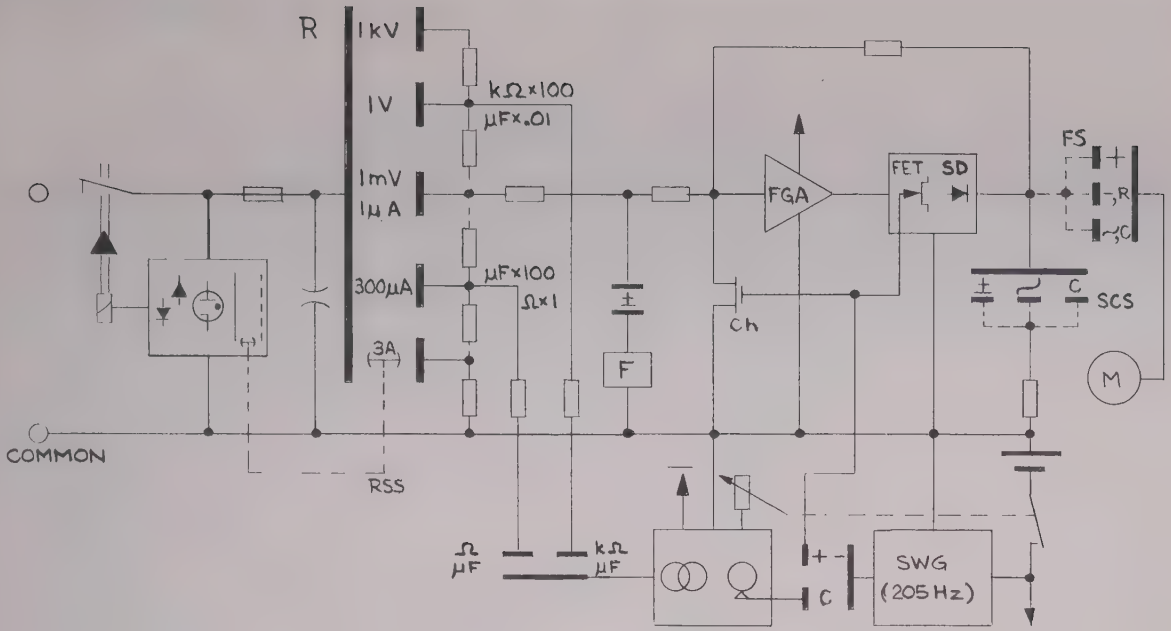


FIGURE 5. CIRCUITRY FOR VOLTAGE AND CURRENT MEASUREMENTS SIMPLIFIED DIAGRAM

No recalibration or zero adjustment is necessary because of the high stability and low drift of the amplifier.

Table 1, below, gives the voltage drops for different current settings.

TABLE 1
VOLTAGE DROPS AT DIFFERENT CURRENT SETTINGS

AC OR DC CURRENT	VOLTAGE DROP
3 A	*500 mV*
1 A	*150 mV*
0.3 A	*50 mV*
0.1 A	*20 mV*
30 mA	*12 mV*
10 mA	*7 mV*
3 mA	*4 mV*
1 mA	*3 mV*
300 μA	*3 mV*
100 μA	*3 mV*
30 μA	*3 mV*
10 μA	*3 mV*
3 μA	*3 mV*
1 μA	*1 mV*

See page 18.

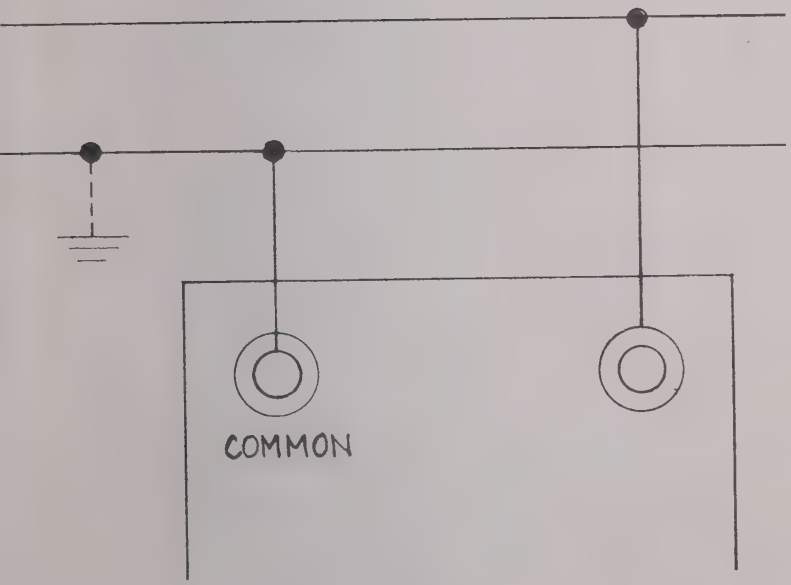


FIGURE 6. DIRECT CONNECTIONS FOR DC AND AC VOLTAGE MEASUREMENTS UP TO 1000 V.

6.2. AC CIRCUIT OPERATION FOR VOLTAGE AND CURRENT MEASUREMENTS

Refer again to Figure 5.

An AC signal passes through the range selector switch (RSS) to the voltage divider (R), and then directly to the fixed-gain amplifier (FGA). An AC signal leaving the amplifier is rectified by two silicon diodes (SD).

As indicated in 6.1, the amplifier gain can be adjusted for DC, AC, or capacitance by the sensitivity control switch (SCS), and the meter movement (M) responds directly to the function switch (FS) settings.

Figure 6, page 17, shows the connections when the multimeter is used without accessories. The existing scales permit measurements in the range from *1 mV to 1000 mV.*

Follow the instructions given below in sequence:

1) Connect the jacks of the 2795 to the leads of the circuit to be measured. The jack marked COMMON should be connected directly to ground or to the lead having the least potential to ground. *The potential above ground applied to the instrument must not exceed 1000 V.*

2) The setting to be used on the range selector will be located either in the mV or V range, depending on measurement desired. Select the setting that you believe is closest to the voltage rating of the circuit you are measuring or start with the highest voltage range mark. In general, it is best to choose a higher range and work down until you reach the setting that

matches the voltage of the circuit you are measuring. This will prevent tripping of the overload relay because of a too-low voltage setting on the range selector.

3) If measuring *DC*, set the function switch on + or −, depending on terminal polarity.

   If measuring *AC*, set the function switch on *AC*.

4) Turn the battery switch to *ON*.

5) Read on the appropriate *V–A* scale *(100 or 30)*.

6.3. MEASUREMENT OF DC VOLTAGE UP TO 30,000 V

The DC voltage measurement range of the 2795 can be expanded to 30,000 V by using the 22926 High-Voltage Probe as a voltage multiplier. Figure 7, page 20, shows the + and − terminal connections for the probe.

Important: In using the 22926 Probe or any other device that permits voltage measurements over 1000 V, observe the following:

1) The protective lead of the probe and the terminal marked COMMON should always be connected to ground potential, as shown in Figure 7, page 20.

2) The range selector should be set on *30 μA*.

3) Set the function on + or −, depending on terminal polarity.

4) Turn the battery switch to *ON*.

5) Measure the voltage by making contact with the 22926 Probe.

6) Read on the *30 V–A* scale and convert to kilovolts.

Important: Do not touch the multimeter while the probe is touching the high-voltage source.

The 22926 High-Voltage Probe is intended only for use in low-current circuits.

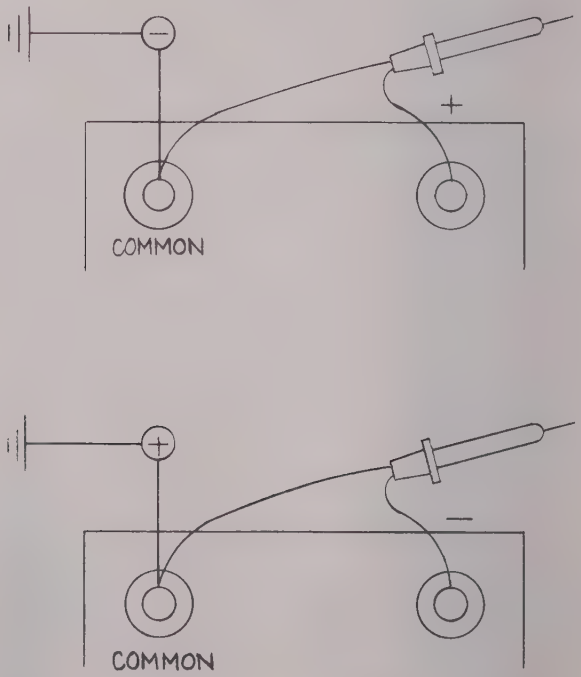


FIGURE 7. CONNECTIONS USING THE 22926 HIGH-VOLTAGE PROBE

6.4. MEASUREMENT OF DC AND AC CURRENT UP TO 3 A

These instructions apply to the use of the multimeter without accessories, using the existing scales, which permit measurements in the range from *1 μA to 3 A*. Refer to Figure 8, page 22, which shows the direct connections for *DC* and *AC* current measurements.

Follow the instructions below in sequence:

1) Connect the jack marked *COMMON* directly to ground or to the lead having the lower potential to ground.

   Important: The potential above ground should never exceed 1000 V.

2) Use any of the following current ranges on the range selector: *μA, mA, or A*. In the appropriate range select the position you believe is closest to the current rating of the circuit you are measuring, or start at the highest current range mark. As mentioned under 6.2, page 16, it is best to start at a higher range and work down until you reach the setting that matches the current of the circuit to be measured. This will prevent tripping the overload relay and breaking the measuring circuit.

3) If measuring *DC*, set the function switch on + or −, depending on terminal polarity.

   If measuring *AC*, set the function switch on *AC*.

4) Turn the battery switch to *ON*.

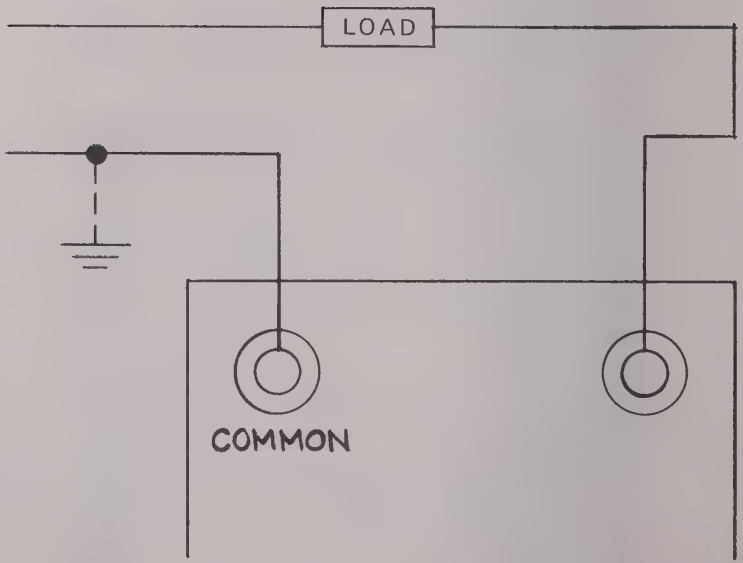


FIGURE 8. DIRECT CONNECTIONS FOR DC AND AC CURRENT MEASUREMENTS

5) Read on the appropriate *V–A* scale *(100 or 30* scale).

6.5. MEASUREMENT OF DC CURRENT UP TO 100 A

DC current between 1 and 100 A (100 mV) can be measured by the 2795 using the 06531 External Shunt, the basic design of which is shown in Figure 9, page 24.

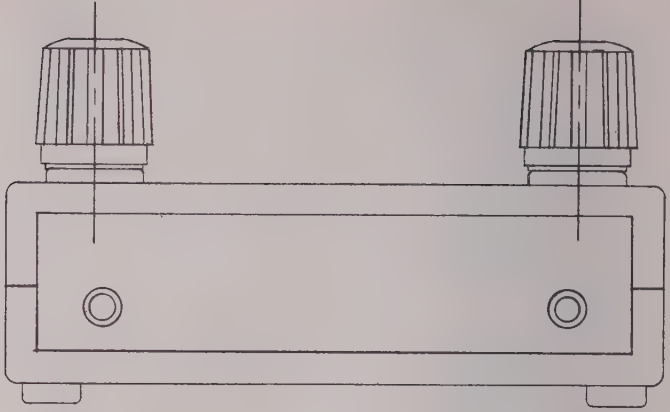
Table 2, below, provides the operating data for the 06531 shunt.

TABLE 2
OPERATING DATA FOR THE 06531 EXTERNAL SHUNT

Range Selector Setting	100 mV	30 mV	10 mV	3 mV	1 mV
Full-Scale Value	100 A	30 A	10 A	2 A	1 A
Function Switch Setting:	+ or –, depending on terminal polarity				

The reading is on: V-A scale.
Additional indicating error is ≤ 0.5% of reading.

Important: The multimeter should be connected to the lead having the lowest potential to ground. For safety reasons, the potential above ground must not exceed 1000 V.



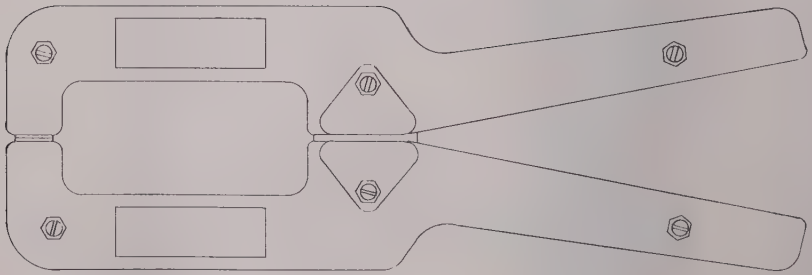


FIGURE 9. 06531 EXTERNAL DC SHUNT AND 02462 CLAMP-ON AC CURRENT TRANSFORMER. BASIC DESIGN.

6.6. MEASUREMENT OF AC CURRENT UP TO 600 A

AC current between 10 and 600 A can be measured by the 2795 using the 02462 Clamp-On Current Transformer.

The measuring circuit is not broken. Transformation ratio for the unit is: 10000:1.

The transformer can be connected to the 2795 by inserting its banana plug in the multimeter jacks.

Table 3. below, gives the different measuring ranges available when the 02462 Clamp-On Current Transformer is used.

TABLE 3

OPERATING DATA FOR THE 02462 CLAMP-ON CURRENT TRANSFORMER

Full-Scale Value	*600 A*	*300 A*	*100 A*	*30 A*	*10 A*
Range Selector Setting	*100 mA**	*30 mA*	*10 mA*	*3 mA*	*1 mA*
Function Switch Setting:	*AC*				
Read on:	*V–A scale. Additional indicating error is from 45 to 65 Hz ≤ 1% of full scale.*				

*The 02462 Transformer should not be used for currents higher than 600 A (60 mA on the scale). At higher currents, the readings will be inaccurate and there may be damage to the transformer.

6.7 MEASUREMENT OF SUPERIMPOSED DC–AC VOLTAGE AND CURRENT

Some systems use both *DC and AC* components. In some cases, the *DC* component is the component that is of primary interest and the *AC* component is the superimposed component; in other cases, such as in many amplifier circuits, the *AC* component is the component of interest and the *DC* the superimposed component.

For measurement purposes, however, the "interest" and superimposed components are equally important because:

1) The "interest" component value must be known, obviously, because it tells the engineer something of importance to him.

2) The superimposed component value must be known because, if it is greater than the "interest" component value, it will interfere with accurate measurement of the "interest" component.

3) Both the "interest" and superimposed components must be known with respect to the range selector setting. If either of these component values is greater than the value of the range selector setting, overload will occur.

Thus, there are two basic problems in superimposed voltage and current measurements:

1) The blocking out or keeping the value low. of the superimposed component.

2) Making sure that the separate values of the "interest" and superimposed components do not exceed the full-scale value of the range selector setting.

The 2795 can be used to measure the voltage or current of both "interest" and superimposed components in composite systems. The separate measurements are made as described in Sections 6.2 through 6.4. Remember that regardless of what device is used to block out the superimposed component, you must always measure both the *DC and AC* components.

RANGE SELECTOR SETTING

Always start at the highest setting or at a setting you believe to be well in excess of either the *DC* or *AC* component value. Measure both the *DC* and *AC* components separately before moving to a lower setting.

BLOCKING OUT AC

When the function switch is set on *DC*. a filter preceding the amplifier will block out the *AC* component *as long as the root-mean-square value of this component does not exceed the full-scale value of the DC component*.

BLOCKING OUT DC

When the function switch is set on *AC*, a blocking capacitor can be installed in series with the instrument to block out the *DC* component. To prevent damage to this blocking

capacitor, make sure that the value of the *DC* component never exceeds the working voltage of the capacitor.

7. MEASUREMENT OF RESISTANCE AND CAPACITANCE

7.1. CIRCUIT OPERATION FOR RESISTANCE AND CAPACITANCE MEASUREMENTS

As you read this section, refer to Figure 10, page 29.

The connections used on the 2795 for the measurement of resistance and capacitance are activated by the constant-current source *(I)*. When the function switch is on μF to measure capacitance, the current is chopped at the square-wave generator (SWG) frequency.

Refer to the switching circuit (SC). For measurements using the resistance settings Ω x 1 and Ω x 10 and the capacitance settings ΩF x 100 and μF x 10, the current passes across this switching circuit to the 300 μA input of the voltage divider (R).

For measurements using the Ω *x 100, all* $k\Omega$ settings and for μF x 1, .1, .01 and .001 settings, the current passes across the switching circuit (SC) to the appropriate input of the voltage divider (R).

Full-scale deflection of the pointer is obtained by turning the battery switch to the Ω, μF Zero ADJ position with the jacks disconnected from any circuit. This method of obtaining full-scale deflection is much simpler than other methods because:

1) There is no need to short-circuit the jacks in order to make a full-scale adjustment.

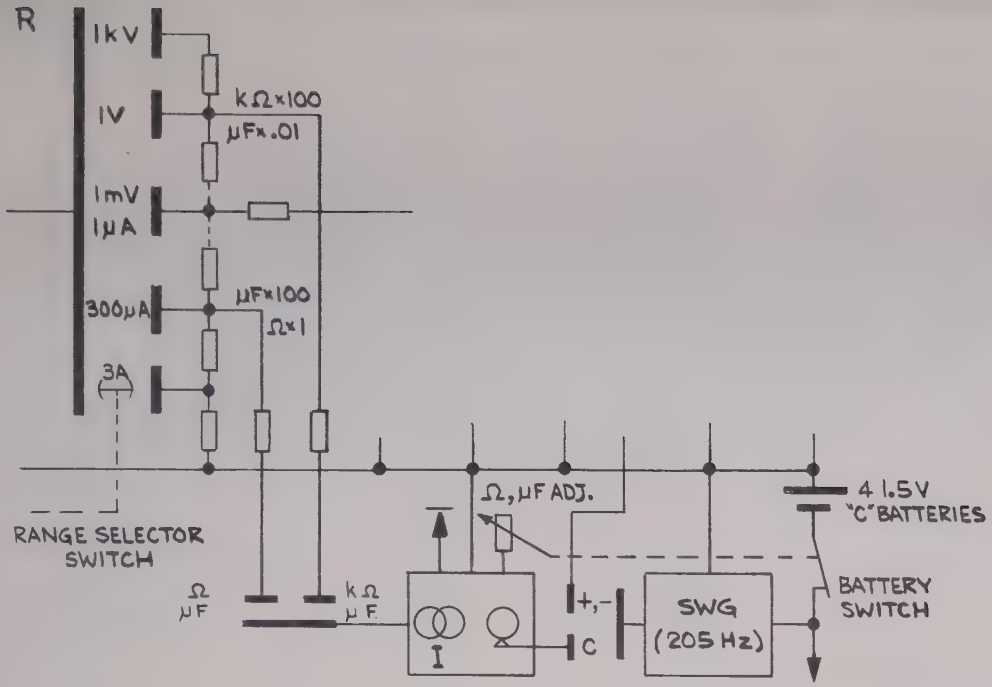


FIGURE 10. CIRCUITRY FOR RESISTANCE AND CAPACITANCE MEASUREMENTS. SIMPLIFIED DIAGRAM.

2) Readjustment for full-scale deflection is required only when switching between the resistance ranges *Ω x 10* and *Ω x 100* and between the capacitance ranges *μF x 1 and μF x 10.* Readjustment is not required when switching between other scales.

3) In making capacitance measurements, neither external AC voltage nor additional connections are necessary.

7.2. MEASUREMENT OF RESISTANCE

Resistance measurements are made using *DC* current. The positive output comes from the COMMON jack. Resistance range data for the 2795 are listed below in Table 4 or they may be referred to under *TECHNICAL DATA* on the back side of the instrument.

TABLE 4. RESISTANCE RANGE DATA

Range Selector Setting	*Measuring Range*	*Mid-Scale Value*	*Maximum Short-Circuit Current*	*Maximum Open-Circuit Voltage*
Ω x 1	0 ... 500Ω	10 Ω	300 μA	3 mV
Ω x 10	0 ... 5 kΩ	100 Ω	30 μA	3 mV
Ω x 100	0 ... 50 kΩ	1000 Ω	1 μA	1 mV
kΩ x 1	0 ,,, 500 kΩ	10 kΩ	1 μA	10 mV
kΩ x 10	0 ... 5 MΩ	200 kΩ	1 μA	100 mV
kΩ x 100	0 ,,, 50 MΩ	1 MΩ	1 μA	1 V

Follow the instructions given below in sequence:

1) Set the range selector at the proper "range factor" setting. The range factors for resistance are located in the Ω *x* ranges at the bottom of the range selector. Resistance readings on the meter scale are multiplied by these range factors; the result is the effective resistance value.

2) Set the function switch on *DC*, – Ω.

3) Adjust the pointer to full scale by turning the battery switch to *ON* and then to the position *μF Zero ADJ*. Obtaining full-scale adjustment is just a matter of turning the battery switch until the pointer rests on ∞.

4) If the range selector is set on any range except Ω *x 1*, you can now connect the terminals of the circuit to be measured with the jacks of the 2795, and can continue with these instructions starting at the paragraph marked *READING* on page 32.

   If the range selector is set on Ω *x 1*, make the full-scale adjustment to ∞ as indicated above. Then touch the two leads firmly together. The pointer will deflect from ∞ to an actual reading on the scale. This reading times the range factor Ω *x 1* is the combined resistance of the 2795 internal circuitry, and should be recorded. Deduct this value from whatever resistance value you get after you connect the leads to the circuit to be measured.

READING

After connecting the jacks of the 2795 to the terminals of the circuit to be measured, you will get a reading on the Ω scale. Multiply this by the range factor; the result is the resistance of the circuit you are measuring. (If you are using the range factor Ω *x 1*, you must deduct the multimeter circuitry and lead resistance from the reading.)

7.3. RESISTANCE-SCALE MEASUREMENT OF DIODES AND TRANSISTORS

The *kΩ x 100* resistance scale can be used to determine:

1) Whether a diode or the base-collector-emitter path of a diode has a short or open circuit and

2) The polarity of a diode or the base lead of a transistor.

The devices being tested cannot be damaged because the test voltage never exceeds *1 V*, and the test current never exceeds *1 μA*.

These tests are of limited value for germanium diodes and diodes with relatively high reverse current because the low test current used does not produce forward and reverse direction readings that differ appreciably.

DETERMINATION OF CIRCUIT CONDITIONS

Follow the instructions given below in sequence:

1) Set the range selector on *100 kΩ*.
2) Set the function switch on *DC*, – Ω.
3) Turn the battery switch to *ON* and then to the Ω, *μF ZERO ADJ* setting in order to get a full-scale reading on the Ω scale.

4) The + terminal of the circuit being measured should always be connected to the *COMMON* jack of the multimeter. All connections are indicated in Table 5, below.

TABLE 5
CONNECTIONS FOR FORWARD AND REVERSE CURRENT
(DIODE AND TRANSISTOR CHECKING)

When you use:	Connect the diode cathode to the multimeter jack:	Connect the transistor base to the multimeter jack:	
		If *pnp:*	If *npn:*
Forward current ($+I_D$)	With the red insert	With red insert	Marked *Common*
Reverse current ($-I_D$)	Marked COMMON	Marked *Common*	With red insert

Read on: $k\Omega$ scale or *100 V-A* scale

DETERMINATION OF POLARITY

You can determine the polarity of an unmarked or Zener diode and the base connection of a *pnp or npn* transistor when testing these devices under forward- and reverse-current conditions.

Check the reading at both forward- and reverse-current settings. At whatever reading is lower:

1) The cathode lead of a diode is the lead connected to the jack *with the red insert.*

2) The base lead of a *pnp* transistor is the lead connected to the jack *with the red insert.*

3) The base lead of an *npn* transistor is the lead connected to the jack marked *COMMON.*

7.4. MEASUREMENT OF CAPACITANCE

Capacitance measurements are carried out using chopped *DC* current.

The range of capacitance measurement available on the 2795 makes it possible to measure electrolytic capacitors. Their lead polarity has no effect on measurement accuracy because the test voltage of such capacitors in the μF ranges is low.

IMPORTANT: Always discharge a capacitor completely before connecting it to the multimeter.

For measurement in the other ranges, connect the capacitor + terminal with the multimeter *COMMON* jack. In resistance and capacitance measurements, the + polarity of the test voltage is on this jack.

Capacitance range data for the 2795 are given below in Table 6 or they may be referred to under *TECHNICAL DATA* on the back side of the instrument.

TABLE 6
CAPACITANCE RANGE DATA

Range Selector Setting	Measuring Range	Mid-Scale Value	Maximum Short-Circuit Current	Maximum Open-Circuit Voltage
μF x 100	0 ..2000 μ F	100 μF	300 μA	3 mV
μF x 10	0 .. 500 μ F	10 μF	30 μA	3 mV
μF x 1	0 .. 50 μ F	1 μF	1 μA	1 mV
μF x .1	0 .. .5 μ F	.1 μF	1 μA	10 mV
μF x .01	0 .. .05 μ F	.01 μF	1 μA	100 mV
μF x .001	0 ..005 μ F	.001 μF	1 μA	1 V

Follow the instructions given below in sequence:

1) Set the range selector at the proper "range factor" setting as indicated in Table 6 above.

2) Set the function switch on *μF.*

3) Adjust the pointer to full scale as indicated in 7.2, page 31, except that full scale on the capacitance *(μF)* range is *0.*

4) Discharge the capacitor system to be measured before connecting it to the multimeter.

5) If you are not using the range factor .001 on the range selector, you can now connect the terminals of the circuit to be measured with the jacks of the 2795, and can continue with these instructions starting at the paragraph marked *READING* on page 36.

If you are using the range factor .001, you must measure the combined capacitance of the multimeter circuitry and the leads before connecting the circuit to be measured to the multimeter jacks. To do this, first connect test leads to the multimeter jacks without connecting them to the circuit under test. Next, set the range selector on the μF x .1 range, and adjust for full-scale reading in the same way as indicated in 7.2, page 31.

Then rotate the range selector to μF x .001. The pointer will now deflect to give a reading on the μF scale. This reading times the range factor .001 is the combined capacitance of the 2795 internal circuitry and the leads and should be recorded. Deduct this value from whatever capacitance value you get after you connect the leads to the circuit to be measured, which you can do now.

READING

6) After you have connected the terminals of the circuit to be measured to the jacks of the 2795, you will get a reading on the *μF* scale. Multiply this by the range factor: the result, if you are using range factors other than .001, is the capacitance of the circuit you are measuring. If you are using range factor .001, as indicated above, you must deduct the multimeter internal circuitry and lead capacitance from the result you get.

IMPORTANT: Capacitance values higher than 2000 *μF* cannot be measured because of the 2795 internal circuitry resistance.

8. MEASUREMENT OF TEMPERATURE

8.1. EQUIPMENT AVAILABLE

Two iron-constantan thermocouple probes, the basic designs of which are shown in Figure 11, page 38, are available for measuring temperature with the 2795. They are:

The 22923 Contact Thermocouple-Probe, for measuring of solid bodies, such as metal parts, windings, etc.

The 22924 Immersion Thermocouple-Probe, for measuring the temperatures of liquid, pulpy, and doughy substances.

Both of these thermocouple-probes have an internal resistance of 2 Ω. Any other iron-constantan thermocouples that have an internal resistance of up to 30Ω, may be used for temperature measurements.

8.2. METHOD OF MEASUREMENT AND VALUES

Note the ΔT *(°C)* scale at the bottom of the dial. ΔT is the difference between the temperature at the tip of the probe and the temperature at the multimeter jacks

ΔT readings are obtained in the following way:

Connect the thermocouple constantan lead, colored blue, to the multimeter *COMMON* jack.

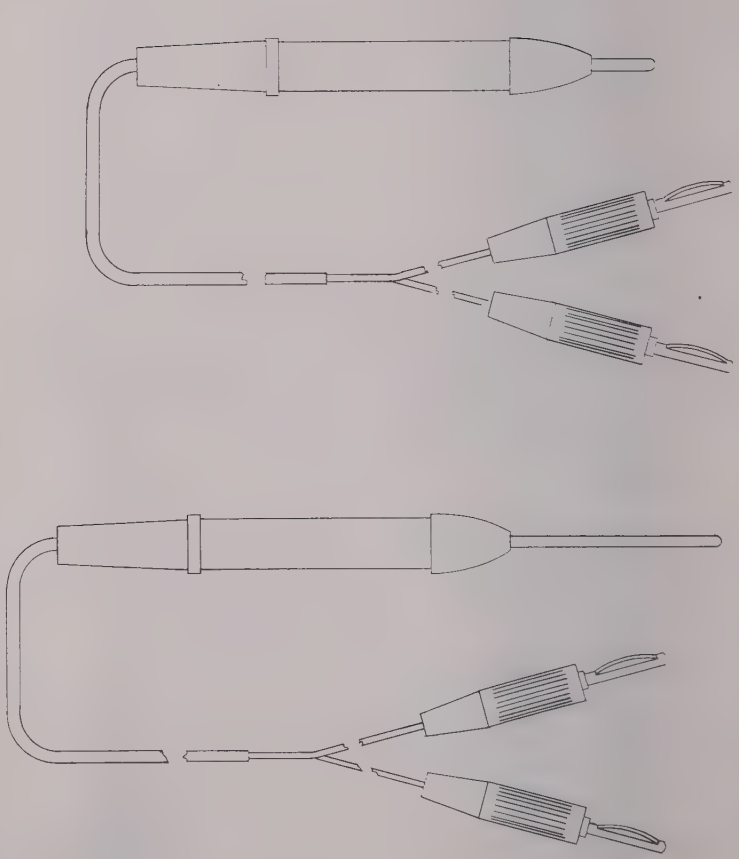


FIGURE 11. 22923 AND 22924 TEMPERATURE PROBES . BASIC DESIGN.

Connect the thermocouple iron lead, colored red, to the red-insert jack of the multimeter.

Set the range selector as follows:

If you wish to measure ΔT Ranges:	*Set on:*
0 to 18°C	1 mV
0 to 57°C	3 mV
0 to 180°C	10 mV
0 to 570°C	30 mV

Set the function switch as follows:

If the temperature at the tip of the probe is:	*Set on:*
Higher than that at the multimeter jacks	+
Lower than that at the multimeter jacks	–

Reading on ΔT *(°C)* scale as follows:

Differential Temperature Measurement Range:	*Get True Value By:*	*Range Selector Setting Is:*
0 to 18 °C	Reading directly in °C	1 mV
0 to 57 °C	Multiplying reading by 3.16	3 mV

Differential Temperature Measurement Range:	*Get True Value By:*	*Range Selector Setting Is:*
0 to 180 °C	Multiplying reading by 10	10 mV
0 to 570 °C	Multiplying reading by 31.6	30 mV

The actual temperature of the system being measured is the value obtained as indicated above *plus* the ambient temperature.

9. MEASUREMENT OF POWER EXPRESSED IN DECIBELS

The power or gain of some systems is expressed in decibels above or below 1 milliwatt *(dBm). The −10 to +12 dBm* scale at the bottom of the multimeter dial, used in conjunction with Table 7, page 41, makes it possible to measure the absolute* *dBm* values of a circuit. Follow the instructions given under 6.2 for measurement of *DC and AC* voltage up to *1000* V; then read on the *dBm* scale.

Table 7 indicates the *dBm* value that should be added to the *dBm* scale reading for specific voltage settings to obtain absolute decibel values. The internal resistance of the 2795 for each setting is also given.

*The zero *dBm* power reference level is *1mW in 600 Ω*. For other-than-*600 mW* systems, the *dBm* reference levels are relative.

TABLE 7 ADDED dBm VALUES		
VOLTAGE DC / AC	*ADD TO dBm READING*	*INTERNAL RESISTANCE*
1000 V	50 dBm	10 *M* Ω
300 V	40 dBm	10 *M* Ω
100 V	30 dBm	10 *M* Ω
30 V	20 dBm	10 *M* Ω
3 V	0 dBm	3 *M* Ω
1 V	−10 dBm	1 *M* Ω
300 V	−20 dBm	300 *k*Ω
100 V	−30 dBm	100 *k*Ω
30 V	−40 dBm	30 *k*Ω
10 V	−50 dBm	10 *k*Ω
3 V	−60 dBm	3 *k*Ω
1 V	−70 dBm	1 *k*Ω

10. MAINTENANCE

The 2795 requires no special maintenance. However, you should check the batteries occasionally, as indicated under 4.4, page 7. Dead or leaking batteries should be removed from the battery compartment immediately.

Be careful to keep the surface between the multimeter jacks clean because a large amount of dirt will impair insulation and reduce the breakdown voltage and input resistance. When voltage ranges of 10 *V* or more are used, the possibility of reducing input resistance is increased.

When the instrument is soiled through dust, liquids, and similar substances, it should be cleaned with a dry rag.

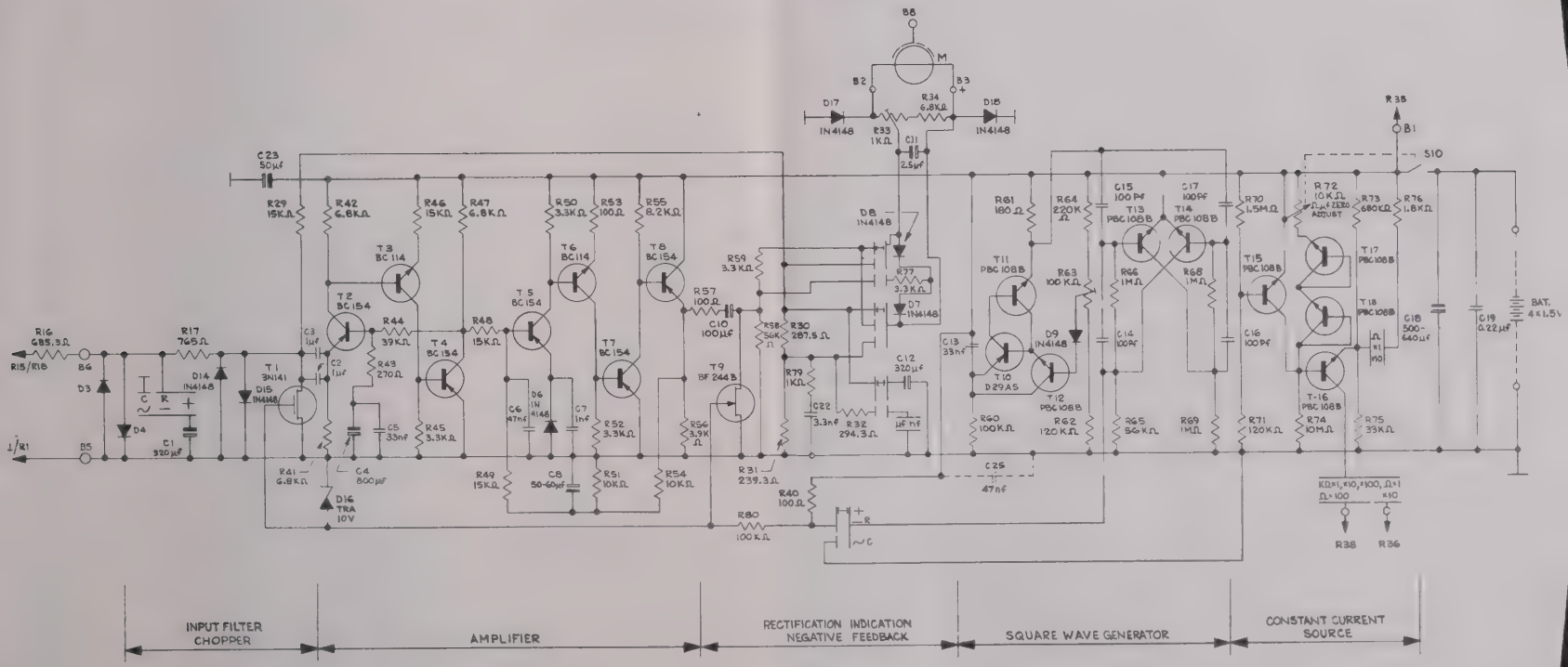
Use a rag moistened with water to:

1) Clean the instrument of materials more difficult to remove than dust, liquid, etc.

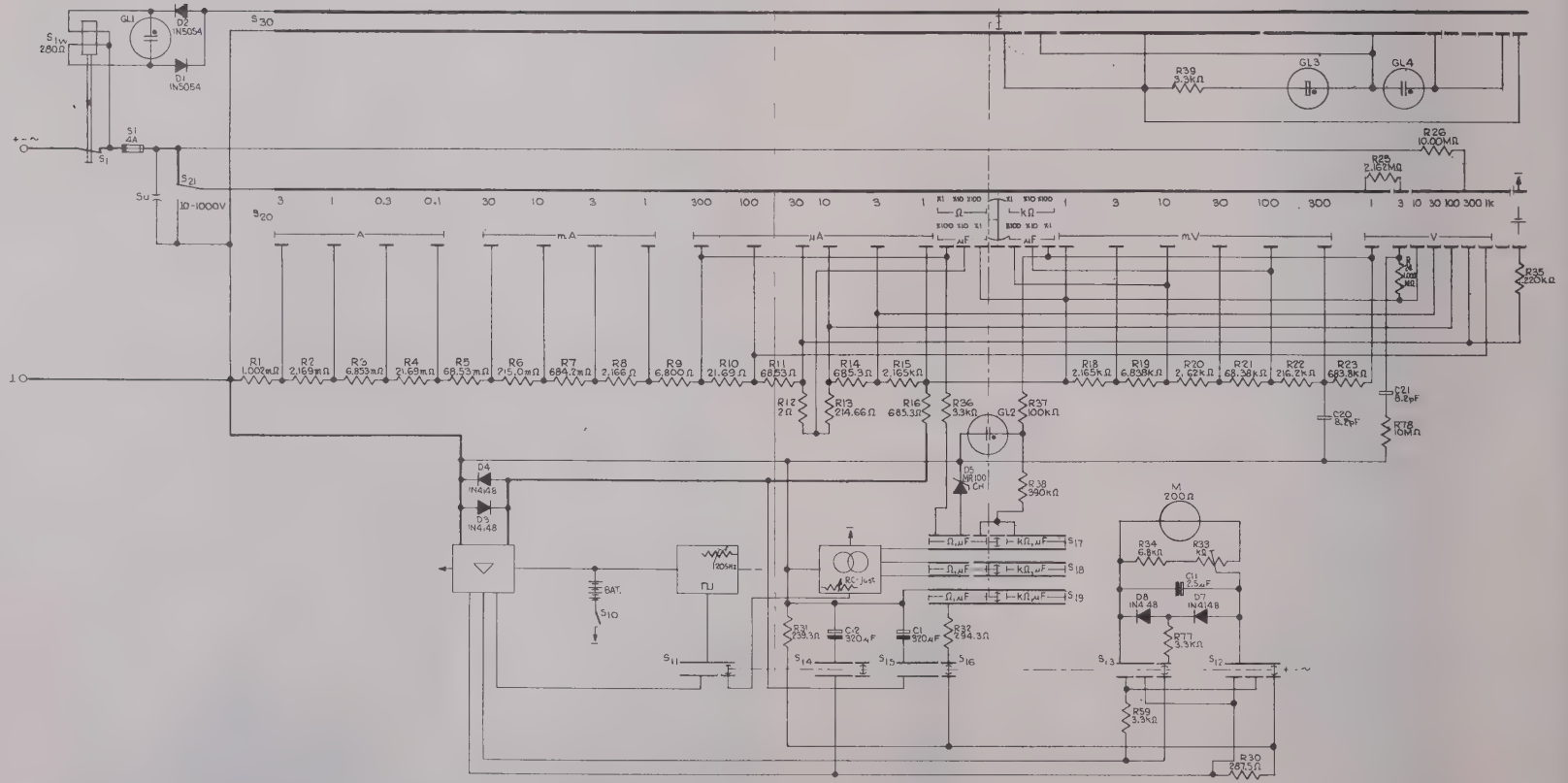
2) Clean the outside of the dial.

Do *not* clean the inside of the window with a rag or other material because it is coated with a substance to prevent the formation of static charges. Such charges could affect pointer deflection.

SCHEMATIC DIAGRAM 1



SCHEMATIC DIAGRAM 2



2795 PARTS LIST

Part	No. of pieces supplied with each unit	See:	Order by Number
Instrument, complete			22795
Meter movement, complete with scale and pointer stop	1	PL 1	GO-000484
Pointer	1	PL 1, No. 1.1	GO-000485
Scale, complete with mirror	1	PL 1, No. 1.2	GO-000486
Pointer stop	1	PL 1, No. 1.3	GO-000487
Scale retaining screws	2	PL 1, No. 1.4	GO-000488
Slotted nuts for holding meter movement	2	PL 1, No. 1.5	GO-000489
Top part of instrument housing, preassembled	1	PL 2, No. 2	GO-000490
Range selector indexing spring	1	PL 1, No. 2.1	GO-000491
Function Switch indexing spring	1	PL 2, No. 2.2	GO-000492
Balls	4	PL 2, No. 2.3	GO-000493
Rubber seal	1	PL 2, No. 3	GO-000494
Shielding plate	1	PL 2, No. 4	GO-000495
Printed circuit board No. 1, complete	1	PL 2, No. 5	GO-000496

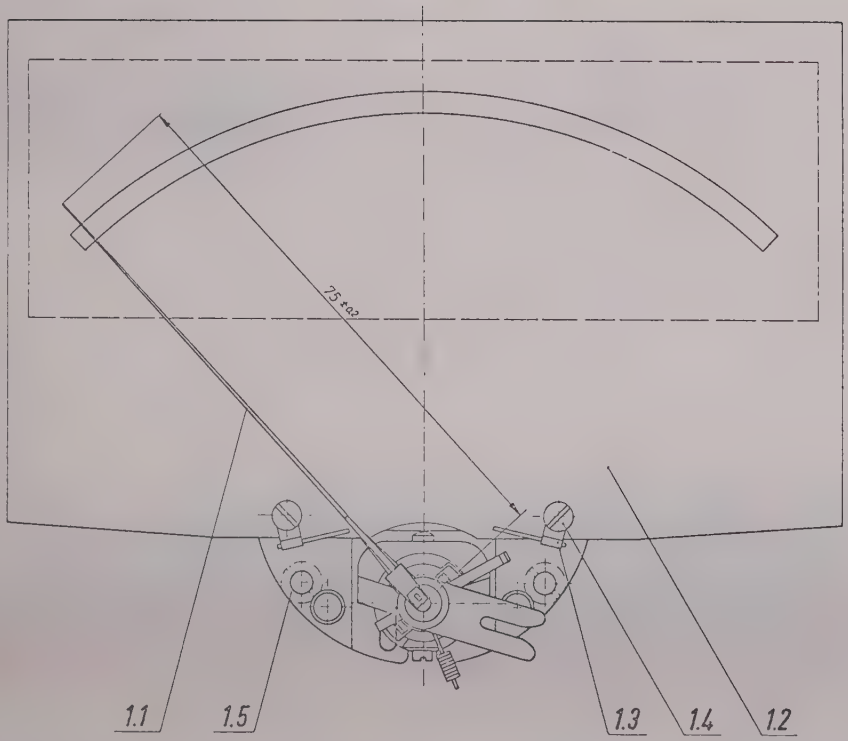
2795 PARTS LIST (Continued)

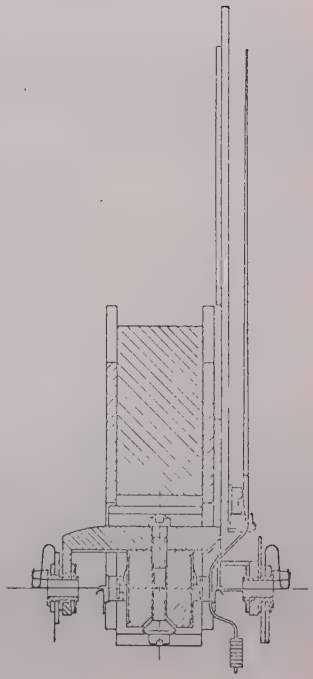
Part	No. of pieces supplied with each unit	See:	Order by Number
Potentiometer with switch	1	PL 2, No. 5.1	GO-000497
Battery contacts	2	PL 2, No. 5.2	GO-000498
Printed circuit board No. 2, complete	1	PL 2, No. 6	GO-000499
Input resistance bypass switch	1	PL 2, No. 6.1	GO-000500
Shunt assembly	1	PL 2, No. 6.2	GO-000501
Printed circuit board No. 3, complete	1	PL 2, No. 7	GO-000502
Spark gap	1	PL 2, No. 7.1	GO-000503
Fuse socket	1	PL 2, No. 7.2	GO-000504
Fuse cap	1	PL 2, No. 7.3	GO-000505
Glass cover for meter movement	1	PL 2, No. 8	GO-000506
Mechanical zero adjuster	1	PL 3, No. 8.1	GO-000507
Nameplate retaining discs	2	PL 3, No. 8.2	GO-000508
Glass cover set screws	2	PL 3, No. 9	GO-000509
Overload reset assembly	1	PL 2, No. 10	GO-000510
Set screw for overload reset	2	PL 2, No. 11	GO-000511
Range adjustment panel	1	PL 3, No. 12	GO-000512

2795 PARTS LIST (Continued)

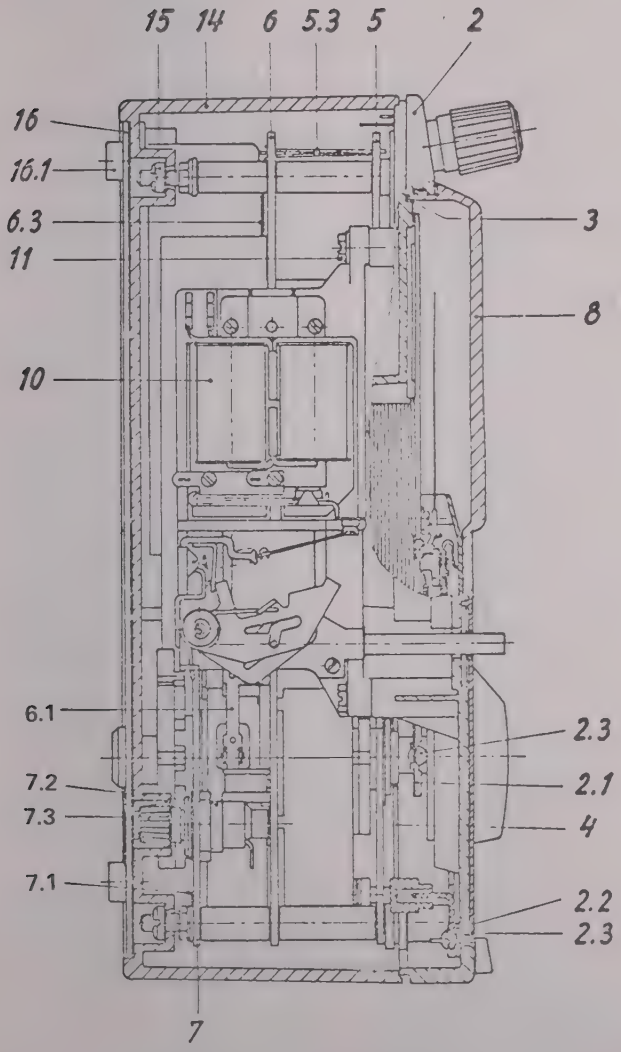
Part	No. of pieces supplied with each unit	See:	Order by Number
Nameplate	1	PL 3, No. 12.1	GO-000513
Set screws for adjustment panel	4	PL 3, No. 13	GO-000514
Bottom part of instrument housing, complete	1	PL 2, No. 14	GO-000515
Slotted nuts for connecting top and bottom housing	4	PL 2, No. 15	GO-000516
Bottom plate, complete	1	PL 2, No. 16	GO-000517
Instrument supports	4	PL 2, No. 16.1	GO-000518
Styrofoam shipping box	1		GO-000519
Operator's manual	1		5-115173

PL 1



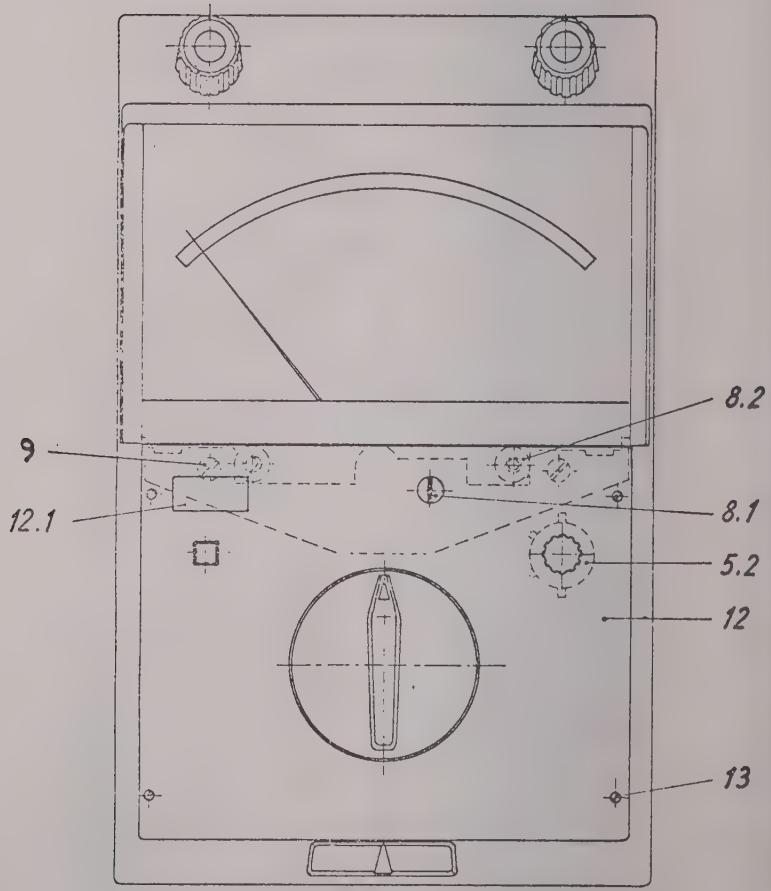


PL1



PL2

PL 3



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□ 1165 S. Cherokee
Tel. (303) 722-5766

* **CONNECTICUT, MIDDLETOWN 06457**
** The Mancib Company
□ Randolph Road and Coe
Tel. (203) 347-5629

* **FLORIDA, FT. LAUDERDALE 33308**
** A&M Instrument Inc.
4257 N.E. 6th Avenue
Tel. (305) 565-2579

FLORIDA, MIAMI 33136
** Florida Precision Instrument Co.
800 N.W. 7th Avenue
Tel. (305) 374-1731

* **FLORIDA, ORLANDO 32806**
** Brownell Electro Inc.
□ 307-27th Street Box 8945
Tel. (305) 843-6770

* **GEORGIA, HAPEVILLE 30054**
** Brownell Electro Inc.
□ P.O. Box 82760
Tel. (404) 762-5181

HAWAII, HONOLULU 96819
** Electronic Measurement Corp.
2979 Ualena Street
Tel. (808) 847-1138

HAWAII, HONOLULU 96819
** Kems Incorporated
239 Puuhale Road
Tel. (808) 847-1395

* **ILLINOIS, CHICAGO 60648**
** A&M Instrument Inc.
6251 W. Touhy
Tel. (312) 774-3500

* **ILLINOIS, ELK GROVE VILLAGE 60007**
** Metermaster Inc.
121 Gordon Street
Tel. (312) 593-8650

* **ILLINOIS, OAK PARK 60302**
** Pacific Indicator Company
□ 6603 W. North Avenue
Tel. (312) 261-1330

INDIANA, EVANSVILLE 47712
** Electro-Lab Services Inc.
510 Williams Road
Tel. (812) 423-5211

KANSAS, SHAWNEE MISSION 66205
** Sturtz Instrument
4705 Mission Road
Tel. (913) 236-4705

* **KANSAS, WICHITA 67211**
** Main Electronics Inc.
225 Ida
Tel. (316) 267-3581

* **LOUISIANA, NEW ORLEANS 70115**
** Industrial Instrument Works
□ 3305 Tchoupitoulas Street
Tel. (504) 895-5621

* **MARYLAND, ELKRIDGE 21227**
** Sunshine Scientific Instruments Inc.
□ 5800 Main Street
Tel. (301) 796-5600

* **MARYLAND, SAVAGE 20863**
** Instrument Specialties Inc.
□ Div. of Pyttronic Industries
8220 Wellmoor Court
Tel. (301) 792-7000

* **MARYLAND, TIMONIUM 21093**
** E.I.L. Instruments Inc.
□ 1830 York Road
Tel. (301) 252-1260

* **MASS., BURLINGTON 01803**
** The Mancib Company
□ Middlesex Turnpike at "A"
Tel. (617) 272-9450

* **MICHIGAN, FERNDALE 48220**
** Ram Meter Inc.
□ 1100 Hilton Road
Tel. (313) 547-1000

* **MINN., MINNEAPOLIS 55427**
** Instrumentation Services Inc.
□ 957 Winnetka Avenue North
Tel. (612) 544-8916

* **MISSOURI, ST. LOUIS 63143**
** Scherrer Instruments Inc.
□ 7170 Manchester
Tel. (314) 644-5362

MONTANA, BILLINGS 59102
** Indust. Electronics & Automation Co.
2442 Grand Avenue
Tel. (406) 656-1313

* **NEW JERSEY, BELLEVILLE 07109**
** Marshall Instruments Inc.
236 Washington Avenue
Tel. (201) 751-1190

* **NEW JERSEY, SO. PLAINFIELD 07080**
** Brownell Electro Inc.
500 Hadley Road
Tel. (201) 753-4600

* **NEW YORK, BUFFALO 14216**
** Trott Electronics Inc.
□ 932 Hertel Avenue
Tel. (716) 876-0880

* **NEW YORK, ROCKVILLE CTR. 11571**
** A&M Instrument Inc.
5 Nassau Street
Tel. (516) 678-6960

* **NEW YORK, NEW YORK 10011**
** Brownell Electro Inc.
85th Tenth Avenue
Tel. (212) 675-2400

* **NEW YORK, NEW YORK 10013**
** Nilsson Electrical Laboratory Inc.
□ 103 Lafayette Street
Tel. (212) 925-1730

NEW YORK, SYRACUSE 13215
** Syracuse Instrument Lab.
4895 South Avenue
Tel. (315) 492-1651

NEW YORK, VESTAL 13850
** Compton Industries
413 Commerce Way
Tel. (607) 729-9221

* **NO. CAROLINA, CHARLOTTE 28214**
** Brownell Electro Inc.
□ 5141 Belhaven Blvd. Box No. 8291
Tel. (704) 394-4341

* **NORTH CAROLINA, RALEIGH 27603**
** Douglas Instruments Inc.
605-07 West South St.
Tel. (919) 832-8536

* **OHIO, CLEVELAND 44105**
** Pioneer/Cleveland Inst. Lab
□ Div. of Pioneer-Standard Elect. Inc.
4800 East 131st Street
Tel. (216) 587-3600

* **OHIO, CLEVELAND 44135**
** Weschler Electric Corp.
4250 West 130th Street
Tel. (216) 251-4609

** **OHIO, COLUMBUS 43219**
Contronics Inc.
2629 Johnstown Road
Tel. (614) 471-6466

* **OHIO, DAYTON 45404**
** Pioneer/Dayton Div. of
□ Pioneer-Standard Elect. Inc.
1900 Troy Street
Tel. (513) 236-9900

* **OKLAHOMA, OKLAHOMA CITY 73107**
** Huston Laboratories Inc.
536 No. Pennsylvania
Tel. (405) 235-5469

* **OKLAHOMA, TULSA 74120**
Agra Engineering Company
551 S. Quaker Avenue
Tel. (913) 584-4235

** **OREGON, PORTLAND 97217**
Westcon Inc.
1910 N. Killingsworth St.
Tel. (503) 285-6629

* **PA., PHILADELPHIA 19115**
** Sunshine Scientific Instruments Inc.
□ 1810 Grant Avenue
Tel. (215) 673-5600

* **PA., PITTSBURGH 15222**
** Cameradio Company
2801 Liberty Avenue
Tel. (412) 288-2600

* **PA., PITTSBURGH 15221**
** E.I.L. Instruments Inc.
□ 1844 Ardmore Blvd.
Tel. (412) 731-5230

* **TENNESSEE, MEMPHIS 38112**
** Brownell Electro Inc.
□ 3053 Tranquility Drive
Tel. (794) 332-9254

TENNESSEE, MEMPHIS 38104
** Instrument Repair Service
1374 Overton Park Avenue
Tel. (901) 278-0762

* **TENNESSEE, NASHVILLE 37210**
** Brownell Electro Inc.
□ 1050 Acorn Drive
Tel. (615) 889-8230

* **TEXAS, DALLAS 75220**
** Ultra Instrument Lab Inc.
□ 9995 Monroe
Tel. (214) 357-0297

** **TEXAS, EL PASO 79901**
Border Electronics
1704 E. Paisano Drive
Tel. (915) 532-2524

* **TEXAS, GARLAND 75040**
** Metermaster Inc.
2815 National Drive
Tel. (214) 271-2471

* **TEXAS, HOUSTON 77006**
** Electrical Instrument &
□ Meter Co. (EIMCO)
1424 Westheimer
Tel. (713) 526-6871 & 72

** **TEXAS, ODESSA 79760**
Meter Service & Supply Company
2127 Kermit Hwy. P.O. Box 2373
Tel. (915) 332-0565

* **VIRGINIA, ALEXANDRIA 22314**
** E.I.L. Instruments Inc.
□ Shirly Hwy. at Edsall Rd.
Tel. (703) 354-4330

* **VIRGINIA, RICHMOND 23229**
** Instrument Technical Reps.
□ 1003 Starling Drive
Tel. (804) 288-7198

* **WASHINGTON, SEATTLE 98105**
** Eicher-Richards Company
□ 2727 N.E. Blakeley Street
Tel. (206) 523-7888

* **WASHINGTON, SEATTLE 98119**
** The Instrument Lab Inc.
932 Elliott Avenue West
Tel. (206) 283-5850

** **WASHINGTON, SPOKANE 99202**
Industrial Instrument Supply Company
E. 2121 Riverside
Tel. (509) 534-9353

* **WISC., MILWAUKEE 53202**
** The Electro-Mechano Company
241 East Erie Street
Tel. (414) 272-4050

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